

# Morphometric Analysis of the Mandible of Tuj and Morkaraman Sheep

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With 2 figures, 4 tables

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## Abstract

In the present study, it was aimed to determine morphometric differences of the mandible of Tuj and Morkaraman sheep having widespread breeding area in the Eastern Anatolia Region. In this study, 20 mandibles of the male Tuj and Morkaraman sheep were used. The 16-lengths taken to the mandible were measured by electronic digital calliper. Furthermore, after the mandible were photographed and printed to milimetric paper, the 4-angles studied were measured with gonimeter. The results of this study proved that the means of the length and angle measurements obtained from Morkaraman sheep were mostly higher than Tuj sheep. The angle of margo ventralis mandibulae (A4)

and the mandible height at the level of the rear alveolar edge with 3rd molar tooth (L14) had a significant statistical difference ( $p<0.05$ ). According to the correlation values, it was seen that A2 values (the angle between the proc. condylaris and ramus mandibulae) of the both sheep breeds were in negative relation with the other mandible measurements. As a result, the obtained data indicate that genetic doesn't significantly affect the morphometry of the mandible of the Morkaraman and Tuj sheeps.

**Keywords:** Mandibula, Morkaraman sheep, Morphometry, Tuj sheep

## Introduction

In Turkey, Morkaraman sheep, which is the dominant race of East-

ern Anatolia Region has numerically in the second rank. Morkaraman sheep is also grown in Iran with name of Kızıl or Gizil. Tuj sheep breeding in North East Anatolia Region belongs to potential of 0.03 % in among the sheep races found in Turkey (Akcapinar, 2000; Kaya, 2001; Ozcan, 1990). Tuj sheep is known as Tuchin in Caucasia Region (Akcapinar, 2000; Ozcan, 1990).

The morphometry is a method of which description and statistical analysis of shape variation is in among samples of organisms. The topics of the morphometry have a wide scale including geographic localities, developmental stages, genetic and environmental effects. The morphometry allows making statistical analysis as numerical or graphical measurements of the length between specific two points or angles (Rohlf and Marcus, 1993).

Some studies have been previously carried out on the mandible morphometry by using different methods in the varied animal species (Alpak, 2003; Ince Gezer and Pazvant, 2010; Olopade and Onwu-ka, 2005; Onar et al., 1999; Yalcin et al., 2007). Ozcan et al. (2010) has been studied about with skull of Morkaraman and Tuj sheeps species. Moreover, mandibles of the Akkaraman and Anatolia Wild have been compared using the geomet-

rical morphometry (Yalcin et al., 2010). The morphometric aspects of the mandible of Mehraban sheep (Karimi et al., 2012), sheep and roe deer (Avdic et al., 2013) have been analysed. However, in the literature, knowledge related to mandible morphometry of Morkaraman and Tuj sheeps was insufficient. For this reason, in the study it was aimed to determine the morphometric differences of the mandible of Morkaraman and Tuj sheep widespreadly found in East Anatolia Region of Turkey.

## Material and Methods

In this study 20 mandibles of male Tuj and Morkaraman (aged 10-12-months) obtained from Kars Municipality Slaughterhouse were used. Weight of animals averaged  $32 \pm 1.8$  kg. The mandibles were separated from the skulls, and their skin and muscles were removed. After the mandibles were macerated for 20-30 minutes with hydrogen peroxide minutes, the 16 differences measurements were by using electronic (0.00, BTS, UK) from the mandibles. These measurements were given in following and at the Fig. (2).

*Length 1(L1):* length between gonion caudale and infradentale.

*Length 2(L2):* length between infradentale and aboral edge of condylar process.

*Length 3(L3)*: length between gonion caudale and aboral alveolar edge of 3<sup>rd</sup> molar tooth.

*Length 4(L4)*: length between infradentale and aboral alveolar edge of 3<sup>rd</sup> molar tooth.

*Length 5(L5)*: length between gonion caudale and rostral alveolar edge of 2<sup>nd</sup> premolar tooth.

*Length 6(L6)*: length between gonion caudale and aboral edge of mental foramen.

*Length 7(L7)*: length between first premolar tooth and last molar tooth.

*Length 8(L8)*: length between first and last molar teeth.

*Length 9(L9)*: length between first and last premolar teeth.

*Length 10(L10)*: length of diestema.

*Length 11(L11)*: length between gonion ventrale and condylion.

*Length 12(L12)*: length between gonion ventrale and the deepest point of incisura mandibulae

*Length 13(L13)*: length between gonion ventrale and coronion.

*Length 14(L14)*: height of mandible level of alveolar edge of 3<sup>rd</sup> molar tooth.

*Length 15(L15)*: height of mandible level of rostral alveolar edge of 1<sup>st</sup> molar tooth.

*Length 16(U16)*: height of mandible level of rostral alveolar edge of 2<sup>nd</sup> premolar tooth.

The terms used in the osteometric measurements;

*Condylion (Cnd)*: The end point of caudal of the processus condylaris

*Coronion (Cr)*: The end point of caudal of the processus coronoideus

*Gonion ventrale (Gv)*: The end point of the ventral border of the angulus mandibulae

*Gonion caudale (Gc)*: The end point of the caudal border of the ramus mandibulae

*Infradentale (Id)*: The rostro-dorsal point of alveoli dentalis between mandibular incisive teeth.

The length measurements of the mandible were shown in Fig(1). The obtained length values were standardized with the length and heights of the mandibles because the animals used in this study were in different ages and live weights. These ratios were determined as L2/L1, L3/L1, L4/L1, L5/L1, L6/L1, L7/L1, L8/L1, L9/L1, L10/L1, L11/L3, L12/L3, L14/L3, L15/L3 and L16/L3.

For measuring the angles, the mandibles were photographed and printed to graph paper. Then after, the four angles were measured with goniometer. These measurements were given in Fig (2).

*Angle 1 (A1)*: angle between margo ventralis mandibulae and margo caudalis mandibulae.

*Angle 2 (A2)*: angle between tuber mandibulae of the condylar process and margo caudalis mandibulae.

*Angle 3 (A3):* angle between ramus mandibulae and margo alveolaris of pars molaris corporis mandibulae.

*Angle 4 (A4):* angle made between rostral edge of the corpus mandibulae and the margo ventralis mandibulae.

In this study, the method of Driesch (1976), based on osteometric length measurements were adopted (Fig 1), while Onar et al., (1999) method, based on angle measurements were followed (fig 2).

Statistical analysis of the study was conducted by using Statistical Package for Social Sciences (SPSS) version 17.0 software package. Continuous variables were stated as arithmetical mean  $\pm$  standard deviation. A Mann-Whitney U test was used to compare the data. Moreover, the correlation of the values obtained from this study was analyzed (Pearson's correlation test). Nomina Anatomica Veterinaria (2005) based for terms used in the study.

## Results and Discussion

The findings of this study were shown in Tables (1, 2, 3,4).

Ketani and Sagsoz (2009) reported that the genetic variation is affected during the development of the mandible. In this study, the mandibles of the Tuj and Morkaraman breeds

had been compared by the morphometric methods. It has been revealed that the genetic variation between the two sheep breeds was expressed by the methods used. Thereby, osteometric and angular measurements among the breeds have been evaluated as statistically and probable differences have been identified. In the study, it has been determined that averages of measurements of the length and angle obtained from Morkaraman sheep have been higher than Tuj sheep. However, it has been investigated that the statistical difference has been in the values of the L14 and A4 ( $p < 0.05$ ). Moreover, the difference of the L14 height in the level of molar teeth of Morkaraman sheep's mandible is higher than Tuj Sheep's mandible, and this height was statistically significant ( $p < 0.05$ ). It is shown that the difference of the A4 values of Tuj Sheep's mandible was more parallel to the ground than Morkaramans' sheep mandible and this parallelism is statistically meaningful ( $p < 0.05$ ).

According to the correlation analysis. Although there was a strong positive and significant correlation among the values of the L2 and L9 in Morkaraman sheep ( $p < 0.01$ ), there was a weak positive and statistically unimportant correlation among the same measurements of Tuj sheep ( $p > 0.05$ ). This value

proved increase or decrease of the length between condyilion and infradentale in Morkaraman sheep is statistically related to the length of the premolar teeth. While there was a strong positive and significant correlation between the values of the L8 and L9 in Morkaraman sheep ( $p < 0.01$ ), there was a weak negative and statistically unimportant correlation in Tuj sheep ( $p > 0.05$ ).

The lengths of the premolar and molar teeth in Morkaraman sheep are linked.

The results of this study proved that the negative correlation was strong and statistically important among of the values of the L14, L15 and L3 in the Morkaraman sheep. In Tuj sheep, a negative, strong and statistically significant correlation has been also detected (except for L15 and L3).

According to the correlation values of the L16 and A2, The parallelism to ground of ramus mandibulae has increased because of the increase in the height of the mandible at the level of the last molar tooth in Morkaraman sheep.

Avdic et al. (2013), mentioned in sheep and roe deer, the values of the L1, L7, L10, L11, L13 and L15 as follows respectively 17.6, 6.20, 4.66, 6.80, 9.96, 2.33 cm in sheep, and 15.6, 6.33, 4.55, 5.85, 8.43, 1.55 in roe deer. In this study, the same values were determined re-

spectively as 15.24, 6.85, 3.72, 6.21, 8.7, 2.12 cm in Morkaraman sheep, and 14.78, 6.61, 3.64, 6.09, 8.54, 2.06 cm in Tuj sheep.

Some morphometric values of Mehra-ban sheep, WAD(West African Dwarf) and Black Bengal goats compared with Morkaraman and Tuj sheep of this study are shown in the *Table (4)*. Accordingly, it has been identified that the longest and highest mandibles respectively belong to Mehraban, Morkaraman and Tuj.

In the present study, the obtained length and height values of the mandibles were standardized because the animals used for research were in different ages and live weights. Accordingly it has been concluded that there is no statistically significant values between the sheep races.

In conclusion, it has been observed that the genetic factor has no influence on the morphometry of mandible in Morkaraman and Tuj sheeps. Although the useful morphometric differences such as the values of the correlation and indices have been presented in line with the conducted statistical analysis.

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**Table (1):** The osteometric and angle measurements of the mandibles of Tuj and Morkaraman sheep. The unit of the mean values and the standard deviations are mm. \*  $p < 0.05$

Measurements	Tuj sheep	Morkaraman sheep
L1	147.76 ± 5.40	152.43 ± 7.47
L2	155.59 ± 5.28	160.43 ± 7.24
L3	43.61 ± 2.32	43.20 ± 4.56
L4	107.86 ± 4.04	112.81 ± 4.81
L5	102.94 ± 2.57	106.97 ± 6.24
L6	118.85 ± 2.52	122.29 ± 5.19
L7	66.14 ± 1.97	68.51 ± 2.70
L8	50.80 ± 1.85	53.12 ± 1.96
L9	14.94 ± 0.84	15.14 ± 0.90
L10	36.44 ± 2.5	37.16 ± 1.88
L11	60.86 ± 1.67	62.08 ± 4.13
L12	55.06 ± 2.26	57.19 ± 4.23
L13	85.37 ± 2.74	86.97 ± 6.08
L14*	36.86 ± 0.53	38.88 ± 1.81
L15	20.61 ± 0.64	21.18 ± 0.55
L16	15.89 ± 0.86	16.40 ± 0.88
A1	101.40 ± 3.21	103.40 ± 3.19
A2	78.60 ± 3.21	76.60 ± 3.19
A3	144.60 ± 5.73	148.30 ± 3.62
A4*	30.80 ± 2.80	39.20 ± 5.66

**Table (2):** The correlation values of the mandibles Tuj and Morkaraman sheeps. '→' The correlation values of Morkaraman sheep, '↓' The correlation values of Tuj sheep. \* p < 0.05, \*\* p < 0.01.

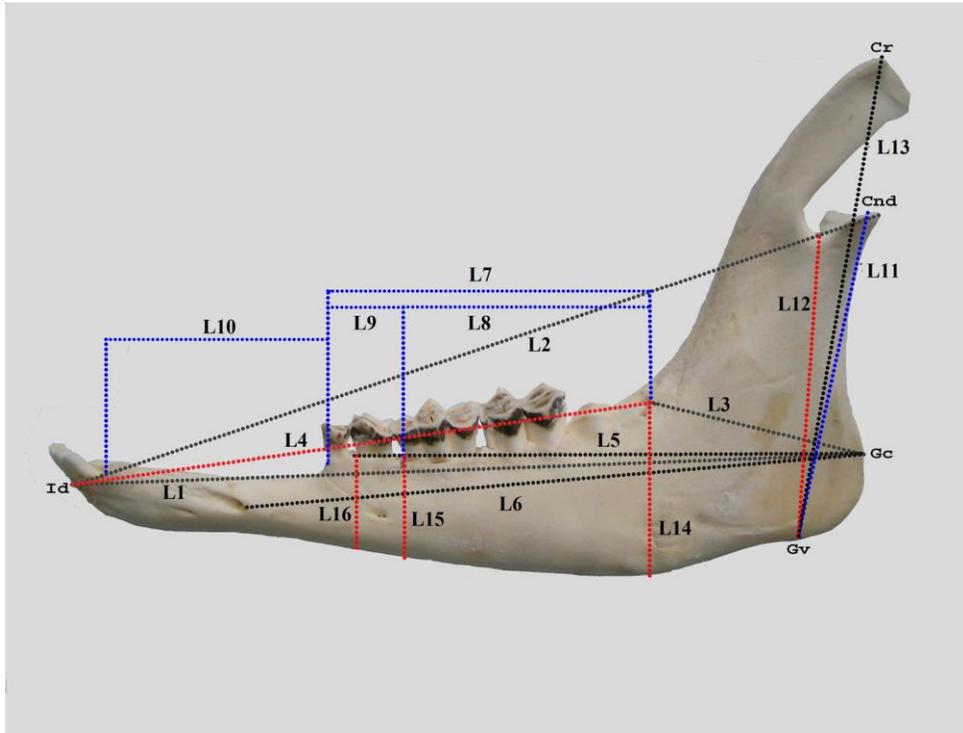
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14*	L15	L16	A1	A2	A3	A4*
L1		.980**	0.861	0.853	.977**	.985**	.914*	0.864	.902**	0.378	.947*	.928*	.968**	0.765	0.672	-0.256	0.075	-0.075	0.749	0.292
L2	.952*		0.765	.893*	.948*	.985**	.972**	.931*	.959**	0.327	.894*	0.835	.899*	0.647	0.512	-0.405	0.229	-0.229	0.751	0.284
L3	0.496	0.271		0.492	.924*	0.797	0.65	0.602	0.839	0.126	.909**	.952*	.943*	.986**	.883*	0.106	-0.349	0.349	0.822	0.164
L4	.962**	.991**	0.274		0.745	.905*	.890*	0.738	0.824	0.622	0.654	0.687	0.745	0.352	0.332	-0.371	0.334	-0.334	0.404	0.513
L5	.946*	0.839	0.54	0.846		.957*	.891*	0.876	.974**	0.196	.989**	.932*	.967**	.849	0.695	-0.175	-0.054	0.054	0.864	0.27
L6	.906*	.920*	0.17	.912*	.910*		.953*	0.873	.981**	0.381	.910*	.887*	.933*	0.69	0.576	-0.251	0.089	-0.089	0.729	0.424
L7	0.658	0.72	-0.067	0.674	0.734	.902*		.955*	.946*	0.217	0.816	0.719	0.797	0.519	0.324	-0.457	0.287	-0.287	0.753	0.361
L8	0.704	0.824	0.25	0.763	0.834	.906*	.928*		.888*	-0.003	0.816	0.648	0.741	0.543	0.289	-0.574	0.346	-0.346	0.853	0.101
L9	0.162	0.177	-0.494	0.271	0.172	0.339	0.258	-0.037		0.216	.940*	.884*	.923*	0.747	0.572	-0.178	-0.022	0.022	0.829	0.439
L10	0.785	0.849	0.323	0.861	0.544	0.582	0.259	0.446	0.037		0.154	0.401	0.382	0.062	0.379	0.014	0.156	-0.156	-0.324	0.367
L11	0.798	0.712	0.174	0.765	0.862	0.866	0.7	0.621	0.644	0.395		.951*	.971**	.917*	0.772	-0.077	-0.166	0.166	0.874	0.226
L12	.930*	0.782	0.766	0.802	.929*	0.736	0.452	0.656	-0.094	0.662	0.712		.991**	.911*	.884*	0.101	-0.275	0.275	0.689	0.35
L13	0.848	0.776	0.449	0.845	0.715	0.636	0.242	0.358	0.359	0.84	0.712	0.82		.884*	0.829	-0.03	-0.155	0.155	0.734	0.314
L14*	-0.22	-0.033	-.927*	-.028	-0.206	0.16	0.378	0.029	0.685	-0.253	0.188	-0.513	-0.262		.911*	0.236	-0.478	0.478	0.781	0.129
L15	-0.238	-0.237	-0.604	-0.139	-0.196	-0.061	-0.07	-0.4	.913*	-0.289	0.325	-0.335	0.048	0.083		0.355	-0.496	0.496	0.468	0.121
L16	0.498	0.639	-0.308	0.693	0.271	0.5	0.265	0.185	0.632	0.733	0.491	0.238	0.69	0.395	0.385		-.947*	.947*	-0.192	0.441
A1	0.36	0.51	-0.17	0.406	0.399	0.618	0.85	0.835	-0.158	0.135	0.222	0.144	-0.142	0.325	-0.39	0.029		1.000*	-0.116	-0.372
A2	-0.36	-0.51	0.17	-0.406	-0.399	-0.618	-0.85	-0.835	0.158	-0.135	-0.222	-0.144	0.142	-0.325	0.39	-0.029	1.000*		0.116	0.372
A3	-0.576	-0.577	0.032	-0.675	-0.426	-0.493	-0.16	-0.095	-0.738	-0.657	-0.68	-0.448	-0.858	-0.187	-0.509	-.887*	0.259	-0.259		0.063
A4*	0.407	0.623	-0.109	0.589	0.113	0.326	0.18	0.302	-0.098	0.825	-0.017	0.173	0.415	0.036	-0.323	0.692	0.317	-0.317		-0.373

**Table (3):** The standardization data of the mandibles of Tuj and Morkaraman sheeps.

Rates	Morkaraman sheep	Tuj sheep
L2/L1	1.05±0.02	1.05±0.01
L3/L1	0.30±0.01	0.28±0.02
L4/L1	0.73±0.01	0.74±0.02
L5/L1	0.70±0.01	0.70±0.01
L6/L1	0.81±0.02	0.80±0.01
L7/L1	0.45±0.01	0.45±0.01
L8/L1	0.34±0.01	0.35±0.01
L9/L1	0.10±0.01	0.10±0.00
L10/L1	0.25±0.01	0.25±0.01
L11/L13	0.71±0.02	0.71±0.01
L12/L13	0.65±0.02	0.66±0.01
L14/L13	0.43±0.02	0.45±0.02
L15/L13	0.24±0.01	0.24±0.01
L16/L13	0.19±0.01	0.19±0.02

**Table (4):** The morphometric data of the mandibles of some sheep and goat races. The unit of the mean values and the standard deviations are cm. (Olopade and Onwuka 2005; Uddin et al., 2009, Advic et al., 2013)

Parameters	Tuj	Morkaraman	Mehraban	WAD	Black
L1	14.78	15.24	15.76	12.00	14.21
L10	3.64	3.72	3.98	-	-
L11	6.09	6.21	7.75	2.68	6.38
L13	8.54	8.7	9.57	6.90	8.83



**Fig (1): The length measurements of the mandible**

*Length 1(L1):* length between gonion caudale and infradentale.

*Length 2(L2):* length between infra-dentale and aboral edge of condylar process.

*Length 3(L3):* length between gonion caudale and aboral alveolar edge of 3<sup>rd</sup> molar tooth.

*Length 4(L4):* length between infra-dentale and aboral alveolar edge of 3<sup>rd</sup> molar tooth.

*Length 5(L5):* length between gonion caudale and rostral alveolar edge of 2<sup>nd</sup> premolar tooth.

*Length 6(L6):* length between gonion caudale and aboral edge of mental foramen.

*Length 7(L7):* length between first premolar tooth and last molar tooth.

*Length 8(L8):* length between first and last molar teeth.

*Length 9(L9):* length between first and last premolar teeth.

*Length 10(L10):* length of diastema.

*Length 11(L11):* length between gonion ventrale and condylion.

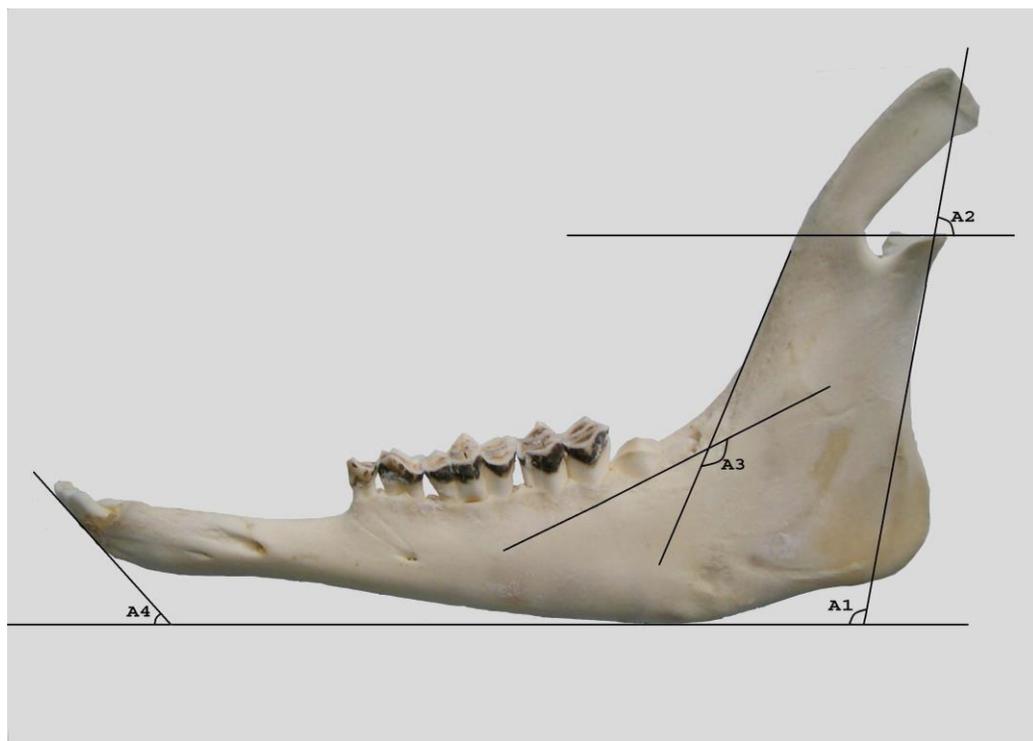
*Length 12(L12):* length between gonion ventrale and the deepest point of incisura mandibulae

*Length 13(L13):* length between gonion ventrale and coronion.

*Length 14(L14):* height of mandible level of alveolar edge of 3<sup>rd</sup> molar tooth.

*Length 15(L15):* height of mandible level of rostral alveolar edge of 1<sup>st</sup> molar tooth.

*Length 16(L16):* height of mandible level of rostral alveolar edge of 2<sup>nd</sup> premolar tooth.



**Fig (2): The angle measurements of the mandible**

- Angle 1 (A1); angle between margo ventralis mandibulae and margo caudalis mandibulae.
- Angle 2 (A2); angle between tuber mandibulae of the condylar process and margo caudalis mandibulae.
- Angle 3 (A3); angle between ramus mandibulae and margo alveolaris of pars molaris corporis mandibulae
- Angle 4 (A4); angle made between rostral edge of the corpus mandibulae and the margo ventralis mandibulae.

\* This study has been presented as a poster in VIII. National (International participation) Veterinary Anatomy Congress organized in Istanbul at 25-28 June 2013.